duties. Mr. D. McAlpine, who has been appointed consulting vegetable pathologist, presents the following summary of the tasks undertaken by his particular section: (1) special investigations concerning the rust of wheat, oats, barley, and other cereals, and, connected with that, the question of rust on various grasses—native and imported; (2) investigations of the life-histories of the various fungus pests, and a knowledge of the best time to cope with them; (3) reports upon diseased specimens sent in from different parts of the colony, and the best known remedies for the palliation or prevention of such diseases; (4) collection of specimens of the various diseases due to fungi, and the subsequent formation of a museum for educational purposes; (5) delivery of lectures in different centres on the fungus pests most prevalent there; (6) preparation of illustrated handbooks, describing the nature of the various diseases and the remedies to be employed where possible; (7) testing various fungicides and the best methods of applying them; (8) visiting different districts in order to find out prevailing and injurious fungi; (9) contributing periodic reports to the official Bulletin of the Department.

IN the Proceedings of the Bath Natural History and Antiquarian Field Club (vol. vii. No. 2), Mr. J. F. Mostyn Clarke gives an account of the geological formations exposed in the cuttings of the Bridgwater Railway, the construction of which opened up a continuous line of excavation through the heart of the Polden Hills. Mr. Clarke had charge of the construction of the railway until near the completion of the earthwork, so that he had excellent opportunities for making careful observations. Geologists may be glad to have his description of the strata when the slopes of the cuttings are overgrown.

MESSRS. LONGMANS, GREEN, AND CO. have published the sixth edition of "An Elementary Treatise on the Integral Calculus," by Dr. Benjamin Williamson, F.R.S. In this edition the work has been revised and enlarged.

MESSRS. MITSCHER AND RÖSTELL, 61*a* Jägerstrasse, Berlin, have issued an important list of books which they have for sale. The works relate to the various departments of botany.

TWO communications upon the volatile carbonyl compounds of platinum, from Dr. Pullinger, of Tübingen, and Drs. Mylius and Foerster, of Charlottenburg, appear in the last number of the *Berichte*. Since the preparation of the remarkable carbonyl compounds of nickel and iron by Messrs. Mond, Langer, and Quincke, these platinum compounds, discovered by Schutzenberger in the year 1868, have become more interesting, and the two papers now before us add considerably to our knowledge of them. They are compounds containing platinum, chlorine, and carbon monoxide, and Schutzenberger assigned to them the formulæ $PtCl_2CO$, $PtCl_2 . 2CO$, and $2PtCl_2 . 3CO$ respectively. He obtained them by heating spongy platinum to a temperature of 250° C. in a stream first of chlorine and afterwards of carbon monoxide. The volatile, readily fusible, and crystalline sublimate obtained contained a mixture of the three, and he effected a separation by extraction with carbon tetrachloride, in which the three compounds are differently soluble. They are well defined by their melting-points, which are 194°, 142°, and 130° C. respectively. They are decomposed by water with separation of platinum, formation of hydrochloric acid, and evolution of carbon dioxide, and also, in case of the second and third compounds, of carbon monoxide. The most stable of these compounds and the best investigated is the simpler one, $COPtCl_2$. It appears to possess a distinctly basic character, so that it is able to combine with hydrochloric acid to form a compound, $COPtCl_2 . HCl$; this compound is formed in solution when the crystals are dissolved in concentrated hydrochloric acid. The two other compounds are decomposed by hydrochloric acid, losing carbon monoxide and forming the hydrochloride of the first compound. On evaporation of the hydrochloric solution, the first compound is left in needle-shaped crystals. When phosgene gas, $COCl_2$, is passed over the crystals, drops of liquid are formed, which consist of a solution of the compound in liquefied carbonyl chloride. In addition to these compounds, the bromide and iodide corresponding to the compound $COPtCl_2$ have been prepared. When the hydrochloric acid solution of the latter is evaporated on a water-bath in a stream of hydrobromic acid gas, and the resulting compound extracted with benzene, the filtered solution deposits, on cooling, orange-red needles of the bromide, $COPtBr_2$. The bromide has likewise been obtained by Dr. Pullinger, by passing carbon monoxide over heated platinous bromide. Similarly, the iodide has been prepared by evaporating crystals of the chloride with excess of hydriodic acid solution, and treating the residue with warm benzene. The crystals of the iodide, $COPtI_2$, which separate from the benzene solution on cooling, are deep red in colour, with a violet surface reflection. The chloride, bromide, and iodide exhibit a beautifully graduated difference of properties. Thus the chloride is yellow, the bromide orange, and the iodide red in colour. The melting-points are 194°, 181°, and 140° respectively. The chloride is readily, the bromide difficultly, and the iodide not at all volatile. The chloride is strongly hygroscopic, the bromide less so, and the iodide permanent. In addition to these compounds, another has been obtained by Dr. Pullinger, of the composition $PtCl_2 . 2COCl_2$, in the form of non-volatile yellow crystals, readily soluble in water, from which it recrystallizes unchanged. It appears to be the most stable of all these platinum compounds, but is only obtained in very small quantity.

OUR ASTRONOMICAL COLUMN.

INFLUENCE OF ABERRATION UPON OBSERVATIONS OF SOLAR PROMINENCES.—Some recent observations of the development and movement of solar prominences have led M. Fizeau to consider the influence that the aberration of light may exercise upon them. A note relative to such an inquiry is contained in *Comptes rendus* for September 7. It is well known that, in consequence of aberration, the longitude of the sun, and therefore of the prominences, is diminished by the amount of the constant, $20''\cdot445$—an apparent displacement depending upon the earth's orbital velocity. And it results from this that if a prominence is developed in the neighbourhood of the ecliptic, and the luminous matter of which it is composed has a velocity of translation equal to the velocity of the earth in its orbit, its position will suffer a displacement of $20''\cdot445$, which may be added to the effect due to the earth's motion, or otherwise, according to the direction of propagation, and thus give rise to corresponding variations in distances from the edge of the sun. As a matter of fact, however, the velocities of prominences are not uniform, and do not commonly attain the required value; nevertheless it seems that the high velocities which have been determined must give rise to apparent movements which depend upon the laws of aberration, and which ought to be taken into account in precise measurements.

Another point touched upon in the communication to which reference has been made is the physical nature of prominences. The simplest hypothesis is that they represent clouds of incandescent hydrogen and other metallic vapours; but M. Fizeau favours the idea that their visibility is the result of the passage of electrical discharges through gaseous material.

NEW ASTEROIDS.—The 317th asteroid was discovered by Charlois on September 8, and the 318th on September 11.

SOME OF THE POSSIBILITIES OF ECONOMIC BOTANY.[1]

OUR Association demands of its President, on his retirement from office, some account of matters connected with the department of science in which he is engaged.

The subject which I have selected for the valedictory address deals with certain industrial, commercial, and economic questions: nevertheless it lies wholly within the domain of botany. I invite you to examine with me some of the possibilities of economic botany.

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[1] Abstract of the Presidential address delivered before the American Association for the Advancement of Science, at Washington, August 1891, by George Lincoln Goodale, M.D., LL.D., Fisher Professor of Natural History, Harvard University, Cambridge, Mass., U.S.A.

Of course, when treating a topic which is so largely speculative as this, it is difficult and unwise to draw a hard and fast line between possibilities and probabilities. Nowadays possibilities are so often realized rapidly that they become accomplished facts before we are aware.

In asking what are the possibilities that other plants than those we now use may be utilized we enter upon a many-sided inquiry. Speculation is rife as to the coming man. May we not ask what plants the coming man will use?

There is an enormous disproportion between the total number of species of plants known to botanical science and the number of those which are employed by man.

The species of flowering plants already described and named are about one hundred and seven thousand. Acquisitions from unexplored or imperfectly explored regions may increase the aggregate perhaps one-tenth, so that we are within very safe limits in taking the number of existing species to be somewhat above one hundred and ten thousand.

Now if we should make a comprehensive list of all the flowering plants which are cultivated on what we may call a fairly large scale at the present day, placing therein all food and forage plants, all those which are grown for timber and cabinet woods, for fibres and cordage, for tanning materials, dyes, resins, rubber, gums, oils, perfumes, and medicines, we could bring together barely three hundred species. If we should add to this short catalogue all the species, which, without cultivation, can be used by man, we should find it considerably lengthened. A great many products of the classes just referred to are derived in commerce from wild plants, but exactly how much their addition would extend the list, it is impossible in the present state of knowledge to determine. Every enumeration of this character is likely to contain errors from two sources: first, it would be sure to contain some species which have outlived their real usefulness; and, secondly, owing to the chaotic condition of the literature of the subject, omissions would occur.

But after all proper exclusions and additions have been made, the total number of species of flowering plants utilized to any considerable extent by man in his civilized state does not exceed, in fact it does not quite reach, one per cent.

The disproportion between the plants which are known and those which are used becomes much greater when we take into account the species of flowerless plants also. Of the five hundred ferns and their allies we employ for other than decorative purposes only five; the mosses and liverworts, roughly estimated at five hundred species, have only four which are directly used by man. There are comparatively few Algæ, Fungi, or Lichens which have extended use.

Therefore, when we take the flowering and flowerless together, the percentage of utilized plants falls far below the estimate made for the flowering alone.

Such a ratio between the number of species known and the number used justifies the inquiry which I have proposed for discussion at this time—namely, can the short list of useful plants be increased to advantage? If so, how?

This is a practical question; it is likewise a very old one. In one form or another, by one people or another, it has been asked from early times. In the dawn of civilization, mankind inherited from savage ancestors certain plants, which had been found amenable to simple cultivation and the products of these plants supplemented the spoils of the chase and of the sea. The question which we ask now was asked then. Wild plants were examined for new uses; primitive agriculture and horticulture extended their bounds in answer to this inquiry. Age after age has added slowly and cautiously to the list of cultivable and utilizable plants, but the aggregate additions have been, as we have seen, comparatively slight.

The question has thus no charm of novelty, but it is as practical to-day as in early ages. In fact, at the present time, in view of all the appliances at the command of modern science and under the strong light cast by recent biological and technological research, the inquiry which we propose assumes great importance. One phase of it is being attentively and systematically regarded in the great experiment stations, another phase is being studied in the laboratories of chemistry and pharmacy, while still another presents itself in the museums of economic botany.

Our question may be put in other words, which are even more practical. What present likelihood is there that our tables may, one of these days, have other vegetables, fruits, and cereals, than those which we use now? What chance is there that new fibres may supplement or even replace those which we spin and weave, that woven fabrics may take on new vegetable colours, that flowers and leaves may yield new perfumes and flavours? What probability is there that new remedial agents may be found among plants neglected or now wholly unknown? The answer which I shall attempt is not in the nature of a prophecy; it can claim no rank higher than that of a reasonable conjecture.

At the outset it must be said that synthetic chemistry has made and is making some exceedingly short cuts across this field of research, giving us artificial dyes, odours, flavours, and medicinal substances, of such excellence that it sometimes seems as if before long the old-fashioned chemical processes in the plant itself would play only a subordinate part. But although there is no telling where the triumphs of chemical synthesis will end, it is not probable that it will ever interfere essentially with certain classes of economic plants. It is impossible to conceive of a synthetic fibre or a synthetic fruit. Chemistry gives us fruit-ethers and fruit-acids, and after a while may provide us with a true artificial sugar and amorphous starch; but artificial fruits worth the eating or artificial fibres worth the spinning are not coming in our day.

Despite the extraordinary achievements of synthetic chemistry, the world must be content to accept, for a long time to come, the results of the intelligent labour of the cultivator of the soil and the explorer of the forest. Improvement of the good plants we now utilize, and the discovery of new ones, must remain the care of large numbers of diligent students and assiduous workmen. So that, in fact, our question resolves itself into this: Can these practical investigators hope to make any substantial advance?

It seems clear that, except in modern times, useful plants have been selected almost wholly by chance, and it may well be said that a selection by accident is no selection at all. Nowadays, the new selections are based on analogy. One of the most striking illustrations of the modern method is afforded by the utilization of bamboo fibre for electric lamps.

Some of the classes of useful plants must be passed by without present discussion; others alluded to slightly, while still other groups fairly representative of selection and improvement will be more fully described. In this latter class would naturally come, of course, the food-plants known as

I. THE CEREALS.

Let us look first at these.

The species of grasses which yield these seed-like fruits, or as we might call them for our purpose seeds, are numerous; twenty of them are cultivated largely in the Old World, but only six of them are likely to be very familiar to you—namely, wheat, rice, barley, oats, rye, and maize. The last of these is of American origin, despite doubts which have been cast upon it. It was not known in the Old World until after the discovery of the New. It has probably been very long in cultivation. The others all belong to the Old World. Wheat and barley have been cultivated from the earliest times; according to De Candolle, the chief authority in these matters, about four thousand years. Later came rye and oats, both of which have been known in cultivation for at least two thousand years. Even the shorter of these periods gives time enough for wide variation, and as is to be expected there are numerous varieties of them all. For instance, Vilmorin, in 1880, figured sixty-six varieties of wheat with plainly distinguishable characters.

If the Chinese records are to be trusted, rice has been cultivated for a period much longer than that assigned by our history and traditions to the other cereals, and the varieties are correspondingly numerous. It is said that in Japan above three hundred varieties are grown on irrigated lands, and more than one hundred on uplands.

With the possible exception of rice, not one of the species of cereals is certainly known in the wild state.

It is out of our power to predict how much time would elapse before satisfactory substitutes for our cereals could be found. In the improvement of the grains of grasses other than those which have been very long under cultivation, experiments have been few, scattered, and indecisive. Therefore we are as badly off for time-ratios as are the geologists and archæologists in their statements of elapsed periods. It is impossible for us to ignore the fact that there appear to be occasions in the life of a species when it seems to be peculiarly susceptible to the influences of surroundings. A species, like a carefully laden ship, represents a balancing of forces within and without. Disturbance may come through variation from within, as from a shifting of the cargo, or in some cases from without. We may suppose both forces to be active in producing variation, a change in the internal condition rendering the plant more susceptible to any change in its surroundings. Under the influence of any marked disturbance, a state of unstable equilibrium may be brought about, at which times the species as such is easily acted upon by very slight agencies.

One of the most marked of these derangements is a consequent of cross-breeding within the extreme limits of varieties. The resultant forms in such cases can persist only by close breeding or by propagation from buds or the equivalents of buds. Disturbances like these arise unexpectedly in the ordinary course of nature, giving us sports of various kinds. These critical periods, however, are not unwelcome, since skilful cultivators can take advantage of them. In this very field much has been accomplished. An attentive study of the sagacious work done by Thomas Andrew Knight shows to what extent this can be done. But we must confess that it would be absolutely impossible to predict with certainty how long or how short would be the time before new cereals or acceptable equivalents for them would be provided. Upheld by the confidence which I have in the intelligence, ingenuity, and energy of our experiment stations, I may say that the time would not probably exceed that of two generations of our race, or half a century.

In now laying aside our hypothetical illustration, I venture to ask why it is that our experiment stations, and other institutions dealing with plants and their improvement, do not undertake investigations like those which I have sketched? Why are not some of the grasses other than our present cereals studied with reference to their adoption as food grains? One of these species will naturally suggest itself to you all—namely, the wild rice of the lakes. Observations have shown that, were it not for the difficulty of harvesting these grains, which fall too easily when they are ripe, they might be utilized. But attentive search might find or educe some variety of *Zizania*, with a more persistent grain and a better yield. There are two of our seashore grasses which have excellent grains, but are of small yield. Why are not these, or better ones which might be suggested by observation, taken in hand?

The reason is plain. We are all content to move along in lines of least resistance, and are disinclined to make a fresh start. It is merely leaving well enough alone, and so far as the cereals are concerned it is indeed well enough. The generous grains of modern varieties of wheat and barley compared with the well-preserved charred vestiges found in Greece by Schliemann, and in the lake-dwellings, are satisfactory in every respect. Improvements, however, are making in many directions; and in the cereals we now have, we possess far better and more satisfactory material for further improvement both in quality and as regards range of distribution than we could reasonably hope to have from other grasses.

From the cereals we may turn to the interesting groups of plants comprised under the general term

II. VEGETABLES.

Under this term it will be convenient for us to include all plants which are employed for culinary purposes, or for table use, such as salads and relishes.

The potato and sweet potato, the pumpkin and squash, the red or capsicum peppers, and the tomato, are of American origin.

All the others are, most probably, natives of the Old World. Only one plant coming in this class has been derived from Southern Australasia—namely, New Zealand spinach (*Tetragonia*).

Among the vegetables and salad-plants longest in cultivation we may enumerate the following: turnip, onion, cabbage, purslane, the large bean (Faba), chick-pea, lentil, and one species of pea (garden-pea). To these an antiquity of at least 4000 years is ascribed.

Next to these, in point of age, come the radish, carrot, beet, garlic, garden-cress, and celery, lettuce, asparagus, and the leek. Three or four leguminous seeds are to be placed in the same category, as are also the black peppers.

Of more recent introduction the most prominent are: the parsnip, oyster-plant, parsley, artichoke, endive, and spinach.

From these lists I have purposely omitted a few which belong exclusively to the tropics, such as certain yams.

The number of varieties of these vegetables is astounding. It is, of course, impossible to discriminate between closely allied varieties which have been introduced by gardeners and seedsmen under different names, but which are essentially identical, and we must therefore have recourse to a conservative authority, Vilmorin, from whose work a few examples have been selected. The varieties which he accepts are sufficiently well distinguished to admit of description, and in most instances of delineation, without any danger of confusion. The potato has, he says, innumerable varieties, of which he accepts forty as easily distinguishable and worthy of a place in a general list; but he adds also a list, comprising, of course, synonyms, of thirty-two French, twenty-six English, nineteen American, and eighteen German varieties. The following numbers speak for themselves, all being selected in the same careful manner as those of the potato: celery more than twenty; carrot more than thirty; beet, radish, and potato, more than forty; lettuce and onion more than fifty; turnip more than seventy; cabbage, kidney-bean, and garden pea, more than one hundred.

The amount of horticultural work which these numbers represent is enormous. Each variety established as a race (that is, a variety which comes true to seed) has been evolved by the same sort of patient care and waiting which we have seen is necessary in the case of cereals, but the time of waiting has not been as a general thing so long.

In the case of the cabbage there are important morphological changes like those to which Prof. Bailey has called attention in the case of the tomato. Suppose we are strolling along the beach at some of the seaside resorts of France, and should fall in with this coarse cruciferous plant, with its sprawling leaves and strong odour. Would there be anything in its appearance to lead us to search for its hidden merit as a food-plant? What could we see in it which would give it a preference over a score of other plants at our feet? Again, suppose we are journeying in the high lands of Peru, and should meet with a strong-smelling plant of the nightshade family, bearing a small irregular fruit, of sub-acid taste and of peculiar flavour. We will further imagine that the peculiar taste strikes our fancy, and we conceive that the plant has possibilities as a source of food. We should be led by our knowledge of the potato, probably a native of the same region, to think that this allied plant might be safely transferred to a northern climate, but would there be promise of enough future usefulness, in such a case as this, to warrant our carrying the plant north as an article of food? Suppose, further, we should ascertain that the fruit in question was relished not only by the natives of its home, but that it had found favour among the tribes of South Mexico and Central America, and had been cultivated by them until it had attained a large size; should we be strengthened in our venture? Let us go one step further still. Suppose that, having decided upon the introduction of the plant, and having urged everybody to try it, we should find it discarded as a fruit, but taking a place in gardens as a curiosity under an absurd name, or as a basis for preserves and pickles; should we not look upon our experiment in the introduction of this new plant as a failure? This is not a hypothetical case.

The tomato, the plant in question, was cultivated in Europe as long ago as 1554; it was known in Virginia in 1781 and in the Northern States in 1785; but it found its way into favour slowly, even in this land of its origin. A credible witness states that in Salem it was almost impossible to induce people to eat or even taste of the fruit. And yet, as you are well aware, its present cultivation on an enormous scale in Europe and this country is scarcely sufficient to meet the increasing demand.

Before asking specifically in what direction we shall look for new vegetables, I must be pardoned for calling attention, in passing, to a very few of the many which are already in limited use in Europe and this country, but which merit a wider employment. Cardon, or cardoon; celeriac, or turnip-rooted celery; fetticus, or corn-salad; martynia; salsify; sea-kale; and numerous small salads, are examples of neglected treasures of the vegetable garden.

The following, which are even less known, may be mentioned as fairly promising;—

(1) *Arracacia esculenta*, called Arracacha, belonging to the parsley family. It is extensively cultivated in some of the northern States of South America. The stems are swollen near

the base, and produce tuberous enlargements filled with an excellent starch. Although the plant is of comparatively easy cultivation, efforts to introduce it into Europe have not been successful, but it is said to have found favour in both the Indies, and may prove useful in our Southern States.

(2) *Ullucus* or Ollucus, another tuberous-rooted plant from nearly the same region, but belonging to the beet or spinach family. It has produced tubers of good size in England, but they are too waxy in consistence to dispute the place of the better tubers of the potato. The plant is worth investigating for our hot dry lands.

(3) A tuber-bearing relative of our common hedge-nettle, or *Stachys*, is now cultivated on a large scale at Crosnes, in France, for the Paris market. Its name in Paris is taken from the locality where it is now grown for use. Although its native country is Japan, it is called by some seedsmen Chinese artichoke. At the present stage of cultivation, the tubers are small and are rather hard to keep, but it is thought "that both of these defects can be overcome or evaded." Experiments indicate that we have in this species a valuable addition to our vegetables.

We must next look at certain other neglected possibilities.

Dr. Edward Palmer, whose energy as a collector and acuteness as an observer are known to you all, has brought together very interesting facts relative to the food-plants of our North American aborigines. Among the plants described by him there are a few which merit careful investigation. Against all of them, however, there lie the objections mentioned before, namely :—

(1) The long time required for their improvement, and

(2) The difficulty of making them acceptable to the community, involving

(3) The risk of total and mortifying failure.

In 1854 the late Prof. Gray called attention to the remarkable relations which exist between the plants of Japan and those of our eastern coast. You will remember that he not only proved that the plants of the two regions had a common origin, but also emphasized the fact that many species of the two countries are almost identical. It is to that country which has yielded us so many useful and beautiful plants that we turn for new vegetables to supplement our present food resources. One of these plants —namely, *Stachys*—has already been mentioned as promising. There are others which are worth examination and perhaps acquisition.

One of the most convenient places for a preliminary examination of the vegetables of Japan is at the railroad stations on the longer lines—for instance, that running from Tokio to Kobe. For native consumption there are prepared luncheon boxes of two or three stories, provided with the simple and yet embarrassing chopsticks. It is worth the shock it causes one's nerves to invest in these boxes and try the vegetable contents. The bits of fish, flesh, and fowl which one finds therein can be easily separated and discarded, upon which there will remain a few delicacies. The pervading odour of the box is that of aromatic vinegar. The generous portion of boiled rice is of excellent quality, with every grain well softened and distinct, and this without anything else would suffice for a tolerable meal. In the boxes which have fallen under my observation there were sundry boiled roots, shoots, and seeds which were not recognizable by me in their cooked form. Prof. Georgeson, formerly of Japan, has kindly identified some of these for me, but he says, "There are doubtless many others used occasionally."

One may find sliced lotus roots, roots of large burdock, lily bulbs, shoots of ginger, pickled green plums, beans of many sorts, boiled chestnuts, nuts of the gingko tree, pickled greens of various kinds, dried cucumbers, and several kinds of seaweeds. Some of the leaves and roots are cooked in much the same manner as beet-roots and beet-leaves are by us, and the general effect is not unappetizing. The boiled shoots are suggestive of only the tougher ends of asparagus. On the whole, I do not look back on Japanese railway luncheons with any longing which would compel me to advocate the indiscriminate introduction of the constituent vegetables here.

But when the same vegetables are served in native inns, under more favourable culinary conditions, without the flavour of vinegar and of the pine wood of the luncheon boxes, they appear to be worthy of a trial in our horticulture, and I therefore deal with one or two in greater detail.

Prof. Georgeson, whose advantages for acquiring a knowledge of the useful plants of Japan have been unusually good, has placed me under great obligations by communicating certain facts regarding some of the more promising plants of Japan which are not now used here. It should be said that several of these plants have already attracted the notice of the Agricultural Department in this country.

The soy bean (*Glycine hispida*). This species is known here to some extent, but we do not have the early and best varieties. These beans replace meat in the diet of the common people.

Mucuna (*Mucuna capitata*) and dolichos (*Dolichos cultratus*) are pole beans possessing merit.

Dioscorea. There are several varieties with palatable roots. Years ago one of these was spoken of by the late Dr. Gray as possessing "excellent roots, if one could only dig them."

Colocasia antiquorum has tuberous roots, which are nutritious.

Conophallus Konjak has a large bulbous root, which is sliced, dried, and beaten to a powder. It is an ingredient in cakes.

Aralia cordata is cultivated for the shoots, and used as we use asparagus.

Œnanthe stolonifera and *Cryptotænia canadensis* are palatable salad plants, the former being used also as greens.

III. FRUITS.

Botanically speaking, the cereal grains of which we have spoken are true fruits—that is to say, are ripened ovaries, but for all practical purposes they may be regarded as seeds. The fruits of which mention is now to be made are those commonly spoken of in our markets as fruits.

First of all, attention must be called to the extraordinary changes in the commercial relations of fruits by two direct causes—

(1) The canning industry, and

(2) Swift transportation by steamers and railroads.

The effects of these two agencies are too well known to require more than this passing mention. By them the fruits of the best fruit-growing countries are carried to distant lands in quantities which surprise all who see the statistics for the first time. The ratio of increase is very startling. Take, for instance, the figures given by Mr. D. Morris, at the time of the great Colonial and Indian Exhibition in London. Compare double decades of years—

	£
1845	886,888
1865	3,185,984
1885	7,587,523

In the Colonial Exhibition at London, in 1886, fruits from the remote colonies were exhibited under conditions which proved that, before long, it may be possible to place such delicacies as the cherimoyer, the sweet-cup, sweet-sop, rambutan, mango, and mangosteen, at even our most northern seaports. Furthermore, it seems to me likely that, with an increase in our knowledge with regard to the microbes which produce decay, we may be able to protect the delicate fruits from injury for any reasonable period. Methods which will supplement refrigeration are sure to come in the very near future, so that even in a country so vast as our own, the most perishable fruits will be transported through its length and breadth without harm.

The canning industry and swift transportation are likely to diminish zeal in searching for new fruits, since, as we have seen in the case of the cereals, we are prone to move in lines of least resistance, and leave well enough alone.

To what extent are our present fruits likely to be improved? Even those who have watched the improvement in the quality of some of our fruits, like oranges, can hardly realize how great has been the improvement within historic times in the character of certain pears, apples, and so on.

The term historic is used advisedly, for there are pre-historic fruits which might serve as a point of departure in the consideration of the question. In the ruins of the lake-dwellings in Switzerland, charred apples have been found, which are in some cases plainly of small size, hardly equalling ordinary crab apples. But, as Dr. Sturtevant has shown, in certain directions there has been no marked change of type—the change is in quality.

In comparing the earlier descriptions of fruits with modern accounts, it is well to remember that the high standards by which fruits are now judged are of recent establishment. Fruits which would once have been esteemed excellent would to-day be passed by as unworthy of regard.

It seems probable that the list of seedless fruits will be materially lengthened, provided our experimental horticulturists make use of the material at their command. The common fruits which have very few or no seeds are the banana, pineapple, and certain oranges. Others mentioned by Mr. Darwin as well known are the bread-fruit, pomegranate, arazole or Neapolitan medlar, and date-palms. In commenting upon these fruits, Mr. Darwin says that most horticulturists "look at the great size and anomalous development of the fruit as the cause, and sterility as the result," but he holds the opposite view as more probable—that is, that the sterility, coming about gradually, leaves free for other growth the abundant supply of building material which the forming seed would otherwise have. He admits, however, that "there is an antagonism between the two forms of reproduction, by seeds and by buds, when either is carried to an extreme degree, which is independent of any incipient sterility."

Most plant-hybrids are relatively infertile, but by no means wholly sterile. With this sterility there is generally augmented vegetative vigour, as shown by Nägeli. Partial or complete sterility, and corresponding luxuriance of root, stem, leaves, and flower may come about in other obscure ways, and such cases are familiar to botanists. Now, it seems highly probable that, either by hybridizing directed to this special end, or by careful selection of forms indicating this tendency to the correlated changes, we may succeed in obtaining important additions to our seedless or nearly seedless plants. Whether the ultimate profit would be large enough to pay for the time and labour involved is a question which we need not enter into; there appears to me no reasonable doubt that such efforts would be successful. There is no reason in the nature of things why we should not have strawberries without the so-called seeds; blackberries and raspberries, with only delicious pulp; and large grapes as free from seeds as the small ones which we call "currants," but which are really grapes from Corinth.

These, and the coreless apples and pears of the future, the stoneless cherries and plums, like the common fruits beforementioned, must be propagated by bud-division, and be open to the tendency to diminished strength said to be the consequence of continued bud-propagation. But this bridge need not be crossed until we come to it. Bananas have been perpetuated in this way for many centuries, and pineapples since the discovery of America, so that the borrowed trouble alluded to is not threatening.

It is absolutely necessary to recollect that, in most cases, variations are slight. Dr. Masters and Mr. Darwin have called attention to this, and have adduced many illustrations, all of which show the necessity of extreme patience and caution. The general student curious in such matters can have hardly any task more instructive than the detection of the variations in such common plants as the blueberry, the wild cherry, or the like. It is an excellent preparation for a practical study of the variations in our wild fruits suitable for selection.

It was held by the late Dr. Gray that the variations in nature by which species have been evolved were led along useful lines—a view which Mr. Darwin regretted he could not entertain. However this may be, all acknowledge that, by the hand of the cultivator, variations can be led along useful lines; and, furthermore, the hand which selects must uphold them in their unequal strife. In other words, it is one thing to select a variety, and another to assist it in maintaining its hold upon existence. Without the constant help of the cultivator who selects the useful variety, there comes a reversion to the ordinary specific type which is fitted to cope with its surroundings.

I think you can agree with me that the prospect for new fruits and for improvements in our established favourites is fairly good.

IV. TIMBERS AND CABINET WOODS.

Can we look for new timbers and cabinet woods? Comparatively few of those in common use are of recent introduction. Attempts have been made to bring into great prominence some of the excellent trees of India and Australia which furnish wood of much beauty and timber of the best quality. A large proportion of all the timbers of the South Seas are characterized by remarkable firmness of texture and high specific gravity. The same is noticed in many of the woods of the Indies. A few of the heavier and denser sorts, like Jarrah, of West Australia, and Sabicu of the Caribbean Islands, have met with deserved favour in England, but the cost of transportation militates against them. It is a fair question whether, in certain parts of our country, these trees, and others which can be utilized for veneers, may not be cultivated to advantage. Attention should be again called to the fact that many plants succeed far better in localities which are remote from their origin, but where they find conditions substantially like those which they have left. This fact, to which we must again refer in detail with regard to certain other classes of plants, may have some bearing upon the introduction of new timber trees. Certain drawbacks exist with regard to the timber of some of the more rapidly growing hard-wood trees which have prevented their taking a high place in the scale of values in mechanical engineering.

One of the most useful soft-wooded trees in the world is the Kauri. It is restricted in its range to a comparatively small area in the North Island of New Zealand. It is now being cut down with a recklessness which is as prodigal and shameful as that which has marked our own treatment of forests here. It should be said, however, that this destruction is under protest; in spite of which it would seem to be a question of only a few years when the great Kauri groves of New Zealand will be a thing of the past. Our energetic Forest Department has on its hands problems just like this which perplexes one of the new lands of the South. The task in both cases is double: to preserve the old treasures and to bring in new.

There is no department of economic botany more promising in immediate results than that of arboriculture.

V. VEGETABLE FIBRES.

The vegetable fibres known to commerce are either plant hairs, of which we take cotton as the type, or filaments of bast-tissue, represented by flax. No new plant hairs have been suggested which can compete in any way for spinning with those yielded by the species of Gossypium, or cotton, but experiments more or less systematic and thorough are being carried on with regard to the improvement of the varieties of the species. Plant hairs for the stuffing of cushions and pillows need not be referred to in connection with this subject.

Countless sorts of plants have been suggested as sources of good bast-fibres for spinning and for cordage, and many of these make capital substitutes for those already in the factories. But the questions of cheapness of production, and of subsequent preparation for use, have thus far militated against success. There may be much difference between the profits promised by a laboratory experiment and those resulting from the same process conducted on a commercial scale. The existence of such differences has been the rock on which many enterprises seeking to introduce new fibres have been wrecked.

In dismissing this portion of our subject it may be said that a process for separating fine fibres from undesirable structural elements and from resin-like substances which accompany them is a great desideratum. If this were supplied, many new species would assume great prominence at once.

VI. TANNING MATERIALS.

What new tanning materials can be confidently sought for? In his "Useful Native Plants of Australia," Mr. Maiden describes over thirty species of "wattles" or acacias, and about half as many eucalypts, which have been examined for the amount of tanning material contained in the bark. In all, eighty-seven Australian species have been under examination. Besides this, much has been done looking in the same direction at the suggestion and under the direction of Baron von Mueller, of Victoria. This serves to indicate how great is the interest in this subject, and how wide is the field in our own country for the introduction of new tanning plants.

It seems highly probable, however, that artificial tanning substances will at no distant day replace the crude matters now employed.

VII. RESINS, &C.

Resins, oils, gums, and medicines from the vegetable kingdom would next engage our attention if they did not seem rather too technical for this occasion, and to possess an interest on the whole somewhat too limited. But an allied substance may serve to represent this class of products and indicate the drift of present research.

India Rubber.—Under this term are included numerous substances which possess a physical and chemical resemblance to each other. An Indian Ficus, the early source of supply, soon became inadequate to furnish the quantity used in the arts even when the manipulation of rubber was almost unknown. Later supplies came from *Hevea* of Brazil, generally known as Para rubber, and from *Castilloa*, sometimes called Central American rubber, and from *Manihot Glaziovii*, Ceara rubber. Not only are these plants now successfully cultivated in experimental gardens in the tropics, but many other rubber-yielding species have been added to the list. The Landolphias are among the most promising of the whole: these are the African rubbers. Now in addition to these, which are the chief source of supply, we have *Willughbeia*, from the Malayan Peninsula, *Leuconotis*, *Chilocarpus*, *Alstonia*, *Forsteronia*, and a species of a genus formerly known as *Urostigma*, but now united with *Ficus*. These names, which have little significance as they are here pronounced in passing, are given now merely to impress upon our minds the fact that the sources of a single commercial article may be exceedingly diverse. Under these circumstances search is being made not only for the best varieties of these species but for new species as well.

There are few excursions in the tropics which possess greater interest to a botanist who cares for the industrial aspects of plants than the walks through the Gardens at Buitenzorg in Java and at Singapore. At both these stations the experimental gardens lie at some distance from the great Gardens which the tourist is expected to visit, but the exertion well repays him for all discomfort. Under the almost vertical rays of the sun, are here gathered the rubber-yielding plants from different countries, all growing under conditions favourable for decisions as to their relative value. At Buitenzorg a well-equipped laboratory stands ready to answer practical questions as to quality and composition of their products, and year by year the search extends.

I mention this, not as an isolated example of what is being accomplished in commercial botany, but as a fair illustration of the thoroughness with which the problems are being attacked. It should be further stated that at the Garden in question assiduous students of the subject are eagerly welcomed, and are provided with all needed appliances for carrying on technical, chemical, and pharmaceutical investigations. Therefore I am justified in saying that there is every reason for believing that in the very near future new sources of our most important products will be opened up, and new areas placed under successful cultivation.

At this point, attention must be called to a very modest and convenient hand-book on the "Commercial Botany of the Nineteenth Century," by Mr. Jackson, of the Botanical Museum attached to the Royal Gardens, Kew, which not only embodies a great amount of well-arranged information relative to the new useful plants, but is, at the same time, a record of the existing state of things in all these departments of activity.

VIII. Fragrant Plants.

Another illustration of our subject might be drawn from a class of plants which repays close study from a biological point of view—namely, those which yield perfumes.

In speaking of the future of our fragrant plants we must distinguish between those of commercial value and those of purely horticultural interest. The former will be less and less cultivated in proportion as synthetic chemistry by its manufacture of perfumes replaces the natural by the artificial products; for example, coumarin, vanillin, nerolin, heliotropin, and even oil of wintergreen.

When, however, one has seen that the aromatic plants of Australia are almost free from attacks of insects and fungi, and has learned to look on the impregnating substances in some cases as protective against predatory insects and small foes of all kinds, and in others as fungicidal, he is tempted to ask whether all the substances of marked odour which we find in certain groups of plants may not play a similar *rôle*.

It is a fact of great interest to the surgeon that in many plants there is associated with the fragrant principle a marked antiseptic or fungicidal quality; conspicuous examples of this are afforded by species of *Eucalyptus*, yielding eucalyptol, *Styrax*, yielding styrone, *Thymus*, yielding thymol. It is interesting to note, too, that some of these most modern antiseptics were important constituents in the balsamic vulneraries of the earliest surgery.

Florists' plants and the floral fashions of the future constitute an engaging subject, which we can touch only lightly. It is reasonably clear that while the old favourite species will hold their ground in the guise of improved varieties, the new introductions will come in the shape of plants with flowering branches which retain their blossoms for a somewhat long period, and especially those in which the flowers precede the leaves. In short, the next real fashion in our gardens is probably to be the flowering shrub and flowering tree, like those which are such favourites in the country from which the Western world has gladly taken the gift of the chrysanthemum.

Twice each year, of late, a reception has been held by the Emperor and Empress of Japan. The receptions are in autumn and in the spring. That in the autumn, popularly known as the Emperor's reception, has for its floral decorations the myriad forms of the national flower, the chrysanthemum; that which is given in spring, the Empress's reception, comes when the cherry blossoms are at their best. One has little idea of the wealth of beauty in masses of flowering shrubs and trees, until he has seen the floral displays in the Imperial Gardens and the Temple grounds in Tokio.

Conclusion.

Lack of time renders it impossible to deal with the questions which attach themselves to our main question, especially as to the limits of effect which cultivation may produce. We cannot touch the problem of inheritance of acquired peculiarities, or the manner in which cultivation predisposes the plant to innumerable modifications. Two of these modifications may be mentioned in passing, because they serve to exemplify the practical character of our subject.

Cultivation brings about in plants very curious morphological changes. For example, in the case of a well-known vegetable the number of metamorphosed type-leaves forming the ovary is two, and yet under cultivation the number increases irregularly until the full number of units in the type of the flower is reached. Prof. Bailey, of Cornell, has called attention to some further interesting changes in the tomato, but the one mentioned suffices to illustrate the direction of variation which plants under cultivation are apt to take. Monstrosities are very apt to occur in cultivated plants, and under certain conditions may be perpetuated in succeeding generations, thus widening the field from which utilizable plants may be taken.

Another case of change produced by cultivation is likewise as yet wholly unexplained, although much studied—namely, the mutual interaction of scion and stock in grafting, budding, and the like. It is probable that a further investigation of this subject may yet throw light on new possibilities in plants.

We have now arrived at the most practical question of all, namely—

In what way can the range of commercial botany be extended? In what manner, or by what means, can the introduction of new species be hastened?

It is possible that some of you are aware of the great amount of uncoordinated work which has been done and is now in hand in the direction of bringing in new plants.

The competition between the importers of new plants is so great both in the Old World and the New that a very large proportion of the species which would naturally commend themselves for the use of florists, for the adornment of greenhouses, or for commerical ends, have been at one time or another brought before the public or are being accumulated in stock. The same is true, although to a less extent, with regard to useful vegetables and fruit. Hardly one of those which we can suggest as desirable for trial has not already been investigated in Europe or this country, and reported on. The pages of our chemical, pharmaceutical, medical, horticultural, agricultural and trade journals, especially those of high grade, contain a wealth of material of this character.

But what is needed is this: that the promising plants should be systematically investigated under exhaustive conditions. It is not enough that an enthusiast here, or an amateur there, should give a plant a trial under imperfectly understood conditions, and then report success or failure. The work should be thorough, and every question answered categorically, so that we might be placed in possession of all the facts relative to the object experimented upon. But such an undertaking requires the co-operation of many different agencies. I shall venture to mention some of these.

In the first place, Botanic Gardens amply endowed for research. The Arnold Arboretum, the Shaw Garden, and the Washington Experimental Garden, are American illustrations of what is needed for this purpose. University gardens have their place in instruction, but cannot wisely undertake this kind of work.

In the second place, Museums and Laboratories of Economic Botany. Much good work in this direction has been done in this country by the National Museum and by the department in charge of the investigation of new plants. We need institutions like those at Kew in England, and at Buitenzorg in Java, which keep in close touch with all the world. The founding of an establishment on a scale of magnitude commensurate with the greatness and needs of our country is an undertaking which waits for some one of our wealthy men.

In the third place, Experiment Stations. These may, within the proper limits of their sphere of action, extend the study of plants beyond the established varieties to the species, and beyond the species to equivalent species in other genera. It is a matter of regret that so much of the energy displayed in these stations in this country, and we may say abroad, has not been more economically directed.

Great economy of energy must result from the recent change by which co-ordination of action is assured. The influence which the stations must exert on the welfare of our country and the development of its resources is incalculable.

In the last place, but by no means least, the co-operation of all who are interested in scientific matters, through their observation of isolated and associated phenomena connected with plants of supposed utility, and by the cultivation of such plants by private individuals, unconnected with any State, Governmental, or academic institutions.

By these agencies, wisely directed and energetically employed, the domains of commercial and industrial botany will be enlarged. To some of the possible results in these domains, I have endeavoured to call your attention.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Prof. Bonney will begin a course of about sixty lectures on geology at University College, London, on Tuesday, October 6, at noon, and a course of about eighteen lectures on geology for engineering students, on Monday, October 12, at 2 p.m. A class for students preparing for the B.Sc. degree in the University of London will meet on October 6 at 2 p.m.

The prizes to the students at the medical school of St. Thomas's Hospital will be distributed to-day by Sir G. M. Humphry, F.R.S.

Lectures will be delivered in Gresham College, Basinghall Street, E.C., on October 6, 7, 8, and 9, by Dr. E. Symes Thompson, Gresham Professor of Medicine, on influenza and its results.

Several series of lectures for which the Salop County Council has made arrangements have been begun. They are on chemistry, botany, geology, agricultural chemistry, management of stock, insect pests and crop diseases, mechanics, and principles of agriculture, and are being given in various parts of the county. Most of them are being delivered in connection with the Oxford University Extension Scheme.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, September 21.—M. Duchartre in the chair.—Admiral Mouchez made some remarks on the second volume of the Paris Observatory Star Catalogue, presented to the Academy. The Catalogue contains stars between the right ascensions 6h. and 12h., and about 500,000 observations made at Paris during the last fifty years have been utilized in its construction.—On the colour sensations excited in one eye by coloured light which illuminates the retina of the other, by M. A. Chauveau. From the experiments described it appears that the excitation of one retina by coloured light influences, not only the optic nerves of this retina, but also those of the opposite side, so that the latter are able to awaken the sensation of the colour employed whilst the excited retina only sees the complementary colour. Thus, if a white surface be observed for a short time through a bit of coloured glass, using only one eye, and screening the other, when the glass is taken away the white ground appears to be tinted with a colour complementary to that of the glass. This is an old experiment, but the point is that if the first eye be closed and the screened eye opened the white surface appears to be tinted with the same colour as the glass.—Observations of the asteroid discovered by Charlois on August 28, made with the *coudé* equatorial of Algiers Observatory, by M. F. Sy. Observations for position were made on August 31 and September 7.—Observations of Wolf's comet (1884 *e* III.) made with the *coudé* equatorial (0·36m. aperture) of Lyons Observatory, by M. G. Le Cadet. Observations for position were made on September 9, 10, 11, and 12.—On the partial eclipse of Jupiter's first satellite by the shadow of the second, by M. J. J. Landerer. This phenomenon occurred on August 14.—The metamorphoses of *Acridium peregrinum*, Oliv., by M. Charles Brongniart. The author has specially observed that locusts undergo various colour changes at different stages of their existence.—On the grafting of underground portions of plants, by M. Lucien Daniel.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Mechanics for Beginners; Part 1, Dynamics and Statics: Rev. J. B. Lock (Macmillan).—Manual of the Science of Religion: Prof. P. D. C. de la Saussaye; translated by B. S. Colyer-Fergusson (Longmans).—Solutions: Prof. Ostwald; translated by M. M. P. Muir (Longmans).—Principles and Practice of Plumbing: S. S. Hellyer (Bell).—Lunar Radiant Heat: O. Boeddicker (Williams and Norgate).—The Universal Atlas, Parts 1 to 6 (Cassell).—Mayhew's Illustrated Horse Doctor, revised and improved: J. I. Lupton (Griffith).—Foods for the Fat, 3rd edition: Dr. Yorke-Davies (Chatto).—On the Adjustment and Testing of Telescopic Objectives: T. Cooke and Sons (York, Johnson).—Die geographische Verbreitung der Säugetiere: Dr. A Nehring (Berlin, Pormetter).—De Klimaten der Voorwereld en de Geschiedenis der Zon: E. Dubois (Batavia, Ernst).—Economic Journal, No. 3 (Macmillan).—Journal of the Asiatic Society of Bengal, Vol. lix., Part 2, Nos. 4 and 5; Vol. lix., Part 2, Supplement No. 2; Vol. lx., Part 2, No. 1 (Calcutta).—Journal of Physiology, vol. xii., No. 4 (Cambridge).—Calendar of the University College of Wales, Aberystwyth, 1891–92 (Manchester, Cornish).—Psychology: F. S. Granger (Methuen).—Studies in Jewish Statistics: J. Jacobs (Nutt).—Diphtheria: Dr. R. Thorne Thorne (Macmillan).—Experiments in Aërodynamics: S. P. Langley (Washington).—The Story of the Heavens, 18th Edition: Sir R. S. Ball (Cassell).—Deutsche Seewarte—Indischer Ozean, Ein Atlas (Hamburg, Friederichsen).—Arithmetical Exercises in Chemistry: Dr. L. Dobbin (Edinburgh, Thin).—La Transcaucasie et la Péninsule D'Apchéron: C. S. Gulbenkian (Paris, Hachette).—Ueber die Finnländischen Rapakiwigesteine: J. J. Sederholm (Wien, Hölder).—Studien über Archäische Eruptivgesteine aus dem Südwestlichen Finnland: J. J. Sederholm (Wien, Hölder).—The Eocene and Oligocene Beds of the Paris Basin: Harris and Burrows (Stanford).—Versuch über die Erdgeschichtliche Entwickelung: Dr. G. Pfeffer (Hamburg, Friederichsen).

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